CLiVEC 7 Cruise Aug 2012: A Report

Dates: August 7th – 24, 2012

Vessel: R/V Bigelow
Location: Northeastern US Continental Margin
Participants: Scott Freeman, Mike Novak, and Dirk Aurin
PI: Jerry Prezioso

The seventh and final cruise for the project entitled **Impacts of Climate Variability on Primary Production and Carbon Distributions in the Middle Atlantic Bight and Gulf of Maine** (CLiVEC) was carried out on board the R/V Henry Bigelow from August 7-24, 2012. CLiVEC is a joint research project with researchers from Old Dominion University (ODU) and the National Oceanographic and Atmospheric Administration (NOAA). The overall objective of the project is to study the effects of inter-annual and decadal climate variability on primary production and carbon distributions using the results from these extensive field measurements as well as the satellite records available from the region.

The Bigelow is a single-hulled research vessel that is 209 feet long (63.8m) and has a breadth of 49.2 ft (15m). It is stationed at the Newport naval base in Rhode Island and operated by NOAA. All previous CLiVEC cruises were carried out on the NOAA R/V Delaware II; however, this vessel has been decommissioned and was no longer available.

All of the CLiVEC field sampling was done on cruises of opportunity made possible by NOAA through the Ecosystems Monitoring Program (EcoMon). EcoMon is an extension of the Marine Resources Monitoring Assessment and Prediction (MARMAP) project begun in 1978 to monitor the health of the fisheries in the northeast US continental margin. On all previous CLiVEC cruises, surface biogeochemical discrete samples were collected from the ship's flow-through sea water system as well as at multiple depths collected from Niskin bottles deployed on a CTD (conductivity, temperature, depth) rosette package maintained by NOAA. Fluorometric dissolved organic matter (FDOM) and beam transmission data were also measured continuously by plumbing instruments into the ships flow through system.

For this final cruise, three Ocean Ecology Laboratory personnel (Scott Freeman, Mike Novak, and Dirk Aurin) participated in order to deploy and compare two free-fall profiling optical radiometers manufactured by different companies to measure Apparent Optical Properties (AOP). An Inherent Optical Properties (IOP) package was also mounted on the CTD rosette and deployed at depths up to 150 meters. In addition, a barrel equipped with a CTD, a WET Labs ac-s, and an FDOM fluorometer was plumbed into the ships flow-through system to make continuous measurements. The instruments were plumbed in-line to avoid any lag time from the resident time of the water in the barrel. More detailed descriptions of these instruments are provided later in this report.

The ship left port mid day after refueling on August 7, 2012. The cruise track headed south from Newport, Rhode Island along the shelf break and then turned towards the coast near North Carolina. The ship traveled back north along the coast until it reached Long Island, and then headed to offshore waters of the Gulf of Maine. The cruise track extended into Canadian waters near Nova Scotia and then returned south along the coast of Maine. The final station was sampled on the evening on August 23 near Boston, Massachusetts. All NOAA operations were completed before heading to port via the Cape Cod Canal.

Staff sampled 53 rosette stations and 26 flow-through stations during the sixteen working days at sea. On average, three CTD rosette stations and two flow-through stations were sampled each day. AOP profiles were conducted before or after the CTD cast when there were no light or weather limitations. A fourth CTD cast was sampled on days with clear skies at times near satellite overpasses when time permitted it. (See Table 1 for an extensive list of discrete and instrumental measurements made at stations).

For oceanographic sampling, the R/V Bigelow was equipped with a SeaBird 9/11 Plus CTD instrument with recording system as well as a chlorophyll fluorescence meter, and

an oxygen sensor (SBE 43). These were attached to a 12-bottle (10 liters each) rosette for the purpose of collecting water at pre-defined depths. The ship has a clean seawater flow through system equipped with a thermosalinograph (TSG) and pCO_2 gas analyzer. A line from the system was plumbed directly into our flow-through instruments mounted on a rack inside the barrel. The barrel was filled with the exhaust water from the instruments to keep them at ambient temperature to avoid any fogging issues.

The following biogeochemical parameters were collected at every station (Table 1):

- HPLC pigments
- particulate absorption (a_p)
- particulate organic carbon (POC)
- absorption due to colored dissolved organic matter (a_{CDOM})
- dissolved organic carbon (DOC)
- suspended particulate matter (SPM) (See Table 1).

Samples for each parameter were collected from the CTD rosette at the surface (~3-4m), the chlorophyll maximum, and just below the thermocline. In addition, water was collected near the bottom at stations that were deeper than 90 meters for CDOM, DOC, and POC.

For in-water optics, staff measured the absorption, attenuation, and backscattering of particles in the water. The IOP package installed on the CTD rosette consisted of a WET Labs ac-s, dh-4, and bb-9. The ac-s measures absorption and attenuation (and total scattering by difference) at ~ 80 wavelengths between 400 and 740 nm, while the bb-9 measures backscatter at 9 wavelengths and 117°. The dh-4 provides power and stores data collected by the other instruments. Downwelling irradiance (E_d) was measured using a Satlantic OCR-7 radiometer mounted to the top of the rosette package, and a Seabird 49 provided pressure, temperature, and conductivity measurements. The system was battery-powered, with files offloaded between casts. Because of the depth limitations of the battery pack (150 m), there were two stations where IOP data was not collected.

Two hand-deployed radiometer packages were also employed. The Satlantic HyperPro system measures E_s (surface downwelling irradiance; separate instrument from the profiler), E_d, and L_u (upwelling radiance) at ~ 135 wavelengths between 350 and 800 nm. The Biospherical C-OPS measures the same parameters at 19 wavelengths between 300 and 900 nm. From these measurements, water leaving radiance (L_w) and remote-sensing reflectance (R_{RS}) can be calculated. A multi-cast method was used for deploying the radiometers. At most stations, one deep cast and two 10m casts were made. Time constraints prevented the staff from using both sets of radiometers each day, as had been planned. However, near the end of the cruise both were used for four stations. At other stations, the Satlantic HyperPro system was used, as it was easier to deploy quickly, and there were a few stations for which the weather conditions did not permit data collection. In total, 46 stations had HyperPro data collected, while five stations had C-OPS data collected.

Tables and Figures:

Figure 1: Station locations for CLiVEC 7 cruise

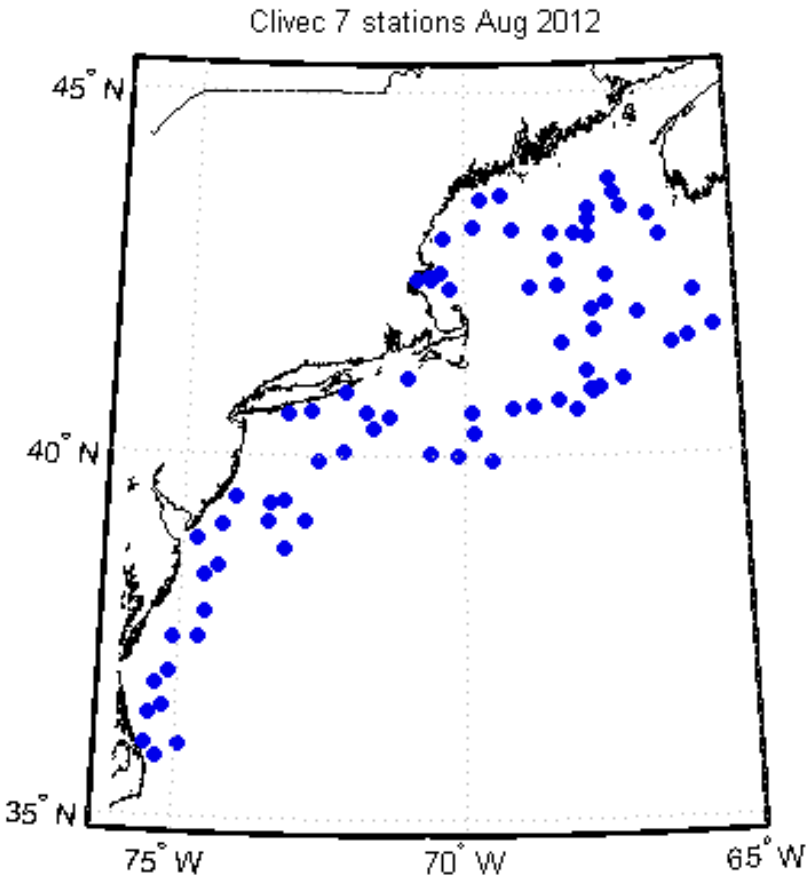

Table 1 Discrete Samples Collected

Parameter	Number of samples collected
HPLC Pigments	208
a_p	208
Particulate Organic Carbon	529
a_{CDOM}	144
Dissolved Organic Carbon	464
Suspended Particulate Matter	104

Table 2 Station Information. The numbers in the last three columns are file names.

Station	Day	GMT	Bottom Depth	Lat	Long	% Cloud	IOPs (a, c, b_b)	Hyperpro (E_d, L_u, E_s)	C-Ops (E_d, L_u, E_s)
2	8/7	2259	38	41.089	-71.042	80	archive.043	2240	
8	8/8	1126	69.8	40.534	-71.366	80	archive.046	1212	
10	8/8	1656	83	40.372	-71.669	100	archive.050	1717	
10.1	8/8	2009	76.2	40.067	-72.192				
11	8/8	2252	58.8	39.917	-72.619	100	archive.051	2222	
19	8/9	1121	99.1	39.093	-72.846	30	archive.052	1141	
21	8/9	1435		39.376	-73.219				
23	8/9	1633	50.3	39.359	-73.457	35	archive.053	1551	
24	8/9	1804	56	39.097	-73.496				
26	8/9	2301	115	38.718	-73.185	40	archive.054	2229	
31	8/10	1146	54.9	37.848	-74.576	100	archive.055	1206	
32	8/10	1414		37.496	-74.657				
34	8/10	1711	32.4	37.461	-75.098	100	archive.056		
34.1	8/10	1958	40.4	36.993	-75.171				
35	8/10	2259	31.7	36.531	-75.235	100	archive.057		
40	8/11	1118	77.6	35.999	-74.921	100	archive.058		
42	8/11	1424	34	35.805	-75.309				
44	8/11	1722	23	35.985	-75.520	100	archive.059		
44.1	8/11	1932	28.2	36.406	-75.461				
45	8/11	2236	24.6	36.810	-75.370	90	archive.060	2156	
52	8/12	1143	40.4	38.327	-74.615	40	archive.061	1158	
53	8/12	1355	46.5	38.473	-74.377				
54	8/12	1703	22	38.822	-74.742	20	archive.062	1641	
54.1	8/12	1945	29.6	39.033	-74.317				
55	8/12	2231	22.1	39.433	-74.077	50	archive.063	2208	
62	8/13	1127	23	40.577	-73.198	0	archive.064	1149	
63	8/13	1344	34.8	40.629	-72.776				
64	8/13	1731	34.4	40.876	-72.155	5	archive.065	1702	
65	8/13	1924	49.3	40.876	-72.155	20	archive.066	1846	
67	8/13	2239	63.1	40.605	-71.782	20	archive.067	2206	
71	8/14	1123	141.6	40.043	-70.603	0	archive.068	1144	
71.1	8/14	1433	187.9	40.016	-70.140				
72	8/14	1915	228.1	39.932	-69.508	10	archive.069	1750	1806
73	8/14	2322	82.6	40.320	-69.822	10	archive.070	2253	
79	8/15	1201	83	40.647	-69.105	10	archive.071	1216	
80	8/15	1408		40.607	-69.884				
81	8/15	1628	64.8	40.682	-68.768	10	archive.072	1557	
82	8/15	1830	59	40.782	-68.287				
83	8/15	2218	89.6	40.635	-67.944	50	archive.073	2139	
89	8/16	1157	49.5	41.049	-67.119	80	archive.074	1209	
90	8/16	1421	66.1	40.930	-67.710				
91	8/16	1639	72.1	40.867	-67.659	10	archive.075	1605	
95	8/16	2231	46.3	41.178	-67.766	0	archive.076	2151	
104	8/17	1120	94.6	41.517	-66.201	0	archive.077	1137	

105	8/17	1414	470	41.605	-65.889				
106	8/17	1804	2014.6	41.756	-65.437	80	archive.078	1657	
107	8/17	2258	228.4	42.226	-65.779	10		2206	
113	8/18	1116	67.8	41.964	-66.798	100	archive.079		
115	8/18	1427	66.4	42.094	-67.397				
116	8/18	1649	68.7	42.019	-67.667	70	archive.080	1610	
117	8/18	1825	42.4	41.735	-67.602				
119	8/18	2317	41.1	41.561	-68.226		archive.081		
124	8/19	1132	203.6	42.331	-68.776	100	archive.082	1146	
125	8/19	1410	204	42.340	-68.287				
126	8/19	1717	194	42.684	-68.286	90	archive.083	1638	
127	8/19	2215	326.4	42.490	-67.374	100	archive.084	2134	
132	8/20	2215	129.9	43.029	-66.344	100	archive.085	1204	
133	8/20	1400	68.8	43.298	-66.538				
134	8/20	1629	232.2	43.402	-67.074	90	archive.086	1610	
134.1	8/20	1914	189.4	43.621	-67.175				
135	8/20	2200	181.4	43.789	-67.244	90	archive.087	2103	
141	8/21	1252	248.2	43.397	-67.688	50	archive.088	1215	
141.1	8/21	1408	236	43.256	-67.684				
142	8/21	1740	171.2	43.036	-67.690	30	archive.091	1545	
143	8/21	1847		43.072	-67.938				
144	8/21	2158	209.7	43.056	-68.364	10	archive.092	2110	
148	8/22	1216	170.5	43.578	-69.306	5	archive.093	1231	
149	8/22	1430	135.9	43.518	-69.710				
150	8/22	1806	183.7	43.159	-69.847	15	archive.094	1703	1720
151	8/22	2008	164.8	43.114	-69.114	30	archive.095	1916	1930
152	8/22	2257	104.6	43.001	-70.418	15	archive.096	2224	
158	8/23	1118	35.6	42.314	-70.277	10	archive.097	1142	
160	8/23	1357	87	42.419	-70.618				
161	8/23	1719	32.8	42.418	-70.855	20	archive.098	1610	1651
162	8/23	1934	80.1	42.465	-70.643	20	archive.099	1856	1831
163	8/23	2244	102.8	42.538	-70.429	10	archive.100	2208	

Photo 1. Bigelow crew prepares the rosette for the sunset station

Photo 2: Dirk Aurin, CJ Stark, and Christian Kernisan process discrete samples in the chemistry wet lab

Photo 3: Scott Freeman prepares to deploy Satlantic Hyperpro.

Photo 4: Sunset observed from the flying bridge of the Bigelow